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The Ruddick Steam Engine.

The accompanying cut which gives a longitudinal section of this engine, will show its extreme simplicity and compactness over any other make of steam engine. The piston heads, AA, are rigidly connected by four rods, the two upper ones showing at FF. These rods insure an equal motion of the two piston-heads in the same direction and at the same time. The piston being thus extended by these rods, admits of the interposition of the connecting rod B, from a wrist-pin in one piston head to the crank-shaft, C, which runs transversly through the cylinder, carrying on one end the belt or fly-wheel, and operating on the other the valve-stem, D, which is moved by the short arm, E, attached to a crank-pin on an adjustable collar fitting on the crank shaft. The valves and steam-chests are represented at HH.

The advantages claimed for this engine are:

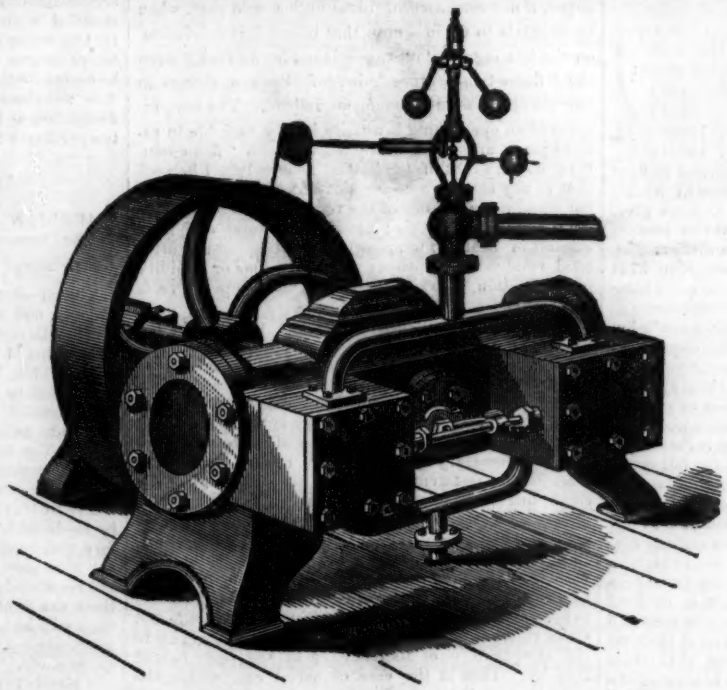
1st. Extreme simplicity, beyond any other make of engine. A reference to the annexed plan and explanation readily confirms this. This quality of simplicity insures—

2d. Fewer parts, and each part contributing directly as a medium of power, and consisting only of the cylinder, piston, connecting rods, crank valves and valve stem.

3rd. Greater saving in repairs, on account of the fewer parts, and equal durability as compared with the best engines.

4th. Greater economy in space and weight than any other engine, and consequent economy in transportation. A 15-horse power engine weighing less than 1000 pounds, is included within a space of 42 inches, longest measurement, all set up with belt wheel, etc., ready to run.

5th. Can be run in any position, and at any reasonable speed. The cylinder must preserve the same right line, and the engine requires no foundation.



RUDDICK STEAM ENGINE.

6th. Greater economy in use, no only from saving in repairs, but the few and simple parts in this engine do not require an experienced engineer to run and keep it in order. Any intelligent boy of 15 could be taught to run and take all needful care of one, in a day's instruction.

7th. Its simplicity insures cheapness and construction, and consequent reduced *cost* to purchasers, while at the same time its cheapness does not in the least particular affect its power and usefulness. On the contrary, its simplicity is a positive mechanical gain, using, as it does, every necessary part, and discarding all that are not directly, and in the shortest line mediums of power. The consumption of power in the engine itself is unavoidably less, and the amount transmitted to the distributing point in like degree greater than in the case of any other engine.

It can be made of any power, from one-half horse power or less, to any required size.

This is not a rotary engine, as might be imagined, but a reciprocating engine, with piston, connecting rod, valves and steam chest, made in the ordinary way, and familiar to all engineers; dispensing with the heavy bed-plate, piston rod, slides and cross heads common to other engines; insuring its extreme simplicity and cheapness, with equal efficiency and greater durability. As a marine engine, for the purpose of driving screw steamers, it is especially recommended, as any required speed may be given to the screw without gearing, and at the same time it occupies much less room of vessel, and is far less ponderous than any plan of engine in use. For this purpose, a link motion is put on for reversing.

For mining purposes, it is said to be peculiarly adapted, from its convenience of setting up, its portability, and also its wide range of adaptability to all the work of the miner. It may be run from 100 to 600 revolutions per minute, with entire freedom and safety.

Further particulars may be had of JOSEPH W. TURNBULL, 115 Liberty street, New York.

Chemical Repertory.--No. 34.

JULY 16, 1870.

Editor—HENRY WURTZ.

Editorial.

HYPERCRITICISM.

In the *Chemical News* of June 24, there is a communication (said to be copied from the *Philosophical Magazine*, which latter I have not yet seen) with criticisms by W. M. WATTS, D. Sc., upon the paper of Prof. SILLIMAN and myself on the "Calorific Powers or Effects of Gases," read to the AM. ASSOCIATION at Salem in August of last year; as forming the *introductory part* of a pending investigation on the important practical subject of the temperatures of the flames of such gases as are ordinarily employed for heating and lighting purposes. This paper was published in the previous issue of the *Chemical News* (also, I believe, in the *Philosophical Magazine* itself; see likewise the *American Journal of Science* for May, 1870, p. 339; the *Jour. of the Franklin Institute* for May, the *London Journal of Gas-Lighting* for May 24, 1870, page 412; and this Journal of March 2, 1870; the latter being the earliest publication).

NOTE ON THE TEMPERATURE AND HEATING-POWERS OF FLAMES.*

By W. M. WATTS, D.Sc.

Mr. WATTS has forwarded to us the following remarks on Messrs. SILLIMAN and WURTZ's paper "On the Temperatures of Flames," which appeared in our last and previous numbers, in which certain conclusions on some practical points of importance are stated.

The following numbers are correctly given as representing the amounts of heat evolved by the complete combustion of equal volumes of the following gases:

Hydrogen	34462
Carbonic oxide	33642
Marsh gas	104504
Olefiant gas	166012

But the conclusion that the heating power of olefiant gas is greater than that of an equal volume of hydrogen is condemned as erroneous; and the authors give, as the result of their investigations, "that the powers of the flames of pure hydrogen and pure olefiant gas, even when used to the greatest advantage, to heat water below its boiling-point, are almost or quite identical."

There seems to be, throughout the paper, a confusion between the *heating-power* of a gas and the *temperature of its flame* in air.

It is quite true that, because the specific heat of steam (which is one of the products of combustion of olefiant gas) is greater than the specific heat of carbonic anhydride (the only product of combustion of carbonic oxide), the calculated flame temperature of the latter gas is higher than that of the former; but, for the very same reason, if these gaseous products of combustion expend their heat in raising the temperature of water, the greatest effect will be produced by the olefiant gas, although the temperature of its flame is not so high as that of the flame of carbonic oxide. If the gases give up the whole of their heat to the water, it is obvious that the calorific effects must be precisely in the ratio of the numbers already quoted; and, even if they escape at a temperature considerably above 0° C., their relative effects will be nearly the same. If we suppose the products of combustion to have a temperature of 200° C. when they escape, the following quantities of heat will still be available by the combustion of equal volumes of carbonic oxide and olefiant gas:

Gas burnt.	Lbs. of water raised from 0° C. to 100° C.
14 lbs. carbonic oxide	314
14 lbs. olefiant gas	1546

And these numbers are almost exactly in the same ratio as the numbers 33642 and 166012. We conclude, therefore, that the numbers quoted (vol. xxi., p. 282), in which, according to Messrs. SILLIMAN and WURTZ, "several most grave errors are involved," do, in reality, strictly represent the heating-effects of the different gases when employed to the greatest advantage, in heating water below 100° C.

The omission of the correction for the latent heat of steam in BUNSEN's original calculation of the temperature of the hydrogen-flame has been already pointed out by DIBBITS.†

In the calculation of the temperature of the hydrogen-flame given in this paper (p. 283), there is also an error in assigning to liquid water the specific heat 0,4805 instead of 1. The formula should be—

$$x = \frac{34462 - 9(637 - 48{\cdot}05)}{4.3245} = 6743^\circ \text{ C.}$$

* From the *Philosophical Magazine*, May, 1870.

† *Pogg. Ann.*, vol. cxxii, p. 497.

Another of the conclusions arrived at in this paper is erroneous, viz., "That, of all known gases, the highest calorific effects,‡ under ordinary atmospheric conditions, are obtainable from *carbonic oxide*, whose calorific value, above 100° C., is about 3000° C."

The flame of cyanogen is hotter than that of carbonic oxide, the calculated temperature of the flame of cyanogen in air being 3519° C., and in oxygen no less than 10557° C. It must be remembered, however, that these results of calculation in no way express the actual flame-temperatures. The calculated temperature of the oxyhydrogen-flame is 6743° C.; but the experiments of DEVILLE‖ and BUNSEN§ agree in fixing it between 2500° C. and 2800° C. The following are the calculated and experimental flame-temperatures of certain gases; it will be seen that the flame of cyanogen is shown by experiment also to have the highest temperture:

	Calculated. °C.	Experimental. °C.
Hydrogen in air	2701	2024
" " oxygen	6743	2844
Carb. oxide in air	2996	1997
" " oxygen	7067	3033
Cyanogen in air	3519	3297
" " oxygen	10557	..
Olefiant gas in air	2727	..
" " oxygen	8606	..

REPLICATION TO MR. WATTS.

Mr. WATTS accuses us first of "confusion" between heating powers and flame-temperatures; not observing that this introductory paper is confined to heating powers or effects, the subject of temperatures being left to future occasions; hence he betrays inattention to our paper, if not confusion of ideas on his own part, when he suggests to us, in a note, that in our first conclusion on the heating *effect* of carbonic oxide, we really mean the "flame-temperature" thereof. Such a change in our wording would be confusion indeed. The temperature of an open flame is usually highly variable in various parts, and we have applied the term "flame-temperature" to that of the hottest zone only. I believe that to any attentive reader, not anxious to pick flaws, our meaning in the use of the term maximum *calorific effect* must be manifest; namely, the total and final amount of heat (so to speak) or heating result, after total combustion; without regard to *time* or rapidity of combustion, of which, of course, the temperature is a function.

Mr. WATTS's reasoning against our result as to the heating effect (*called by him flame-temperature*) of olefiant gas being lower than that of carbonic oxide, especially compels me to think that he has not read our paper with that rttention which so confident a criticism should imply. This reasoning may apply, partially at least, to the case of the combustion of these two gases with the necessary amount of *pure oxygen*, being then essentially a restatement (though not complete) of the conditions of the actual experiments of FAVRE and SILBERMANN; but is wide of any application to our own case, in which the *nitrogen of the air* plays a large part. In burning in the air, as a simple calculation shows, one volume of CO has to heat but two volumes of N and half a volume of O, whereas one volume of olefiant has to heat more than 11 (exactly 11.29) volumes of N and three volumes of O, or 14.29 volumes altogether, up to the temperature of its flame, or of the body heated thereby. Thus in the case of aerial combustion, the total heat of the olefiant volume is distributed or *divided* throughout 5.72 times greater bulk of air than is the case with carbonic oxide. Hence (in part) the lower calorific effect of olefiant in air, even when the latent heat of the steam of combustion is recovered by condensation. Of these, with other things, Mr. WATTS takes no heed, and in view thereof I think that we can justly retort his accusation of "confusion."

As to the correction necessary in BUNSEN's Gasometry, for the heat of the steam of combustion of hydrogen, we were informed that this had been made, but not by whom. Our informant, Professor COOKE of Cambridge, thought by BUNSEN himself, but we were unable to verify this, and in a note to our paper as published in *Am. Jour. of Science* (page 342), referred to the subject somewhat doubtfully. Our thanks are therefore due to Mr. WATTS for the reference to DIBBITS.

The exception made by Mr. WATTS to the formula for the total calorific of hydrogen relating to the correction for the difference between the specific heats of water and steam, is one which I cannot at present individually enter upon, and to which I shall again return. I will merely say that there has been controversy upon the points here involved; mentioning also that the number calculated by DEVILLE for the total calorific power of hydrogen in oxygen is 6800°, which is about the mean between Mr. WATTS, and the figure adopted by us (*See Revue des Cours Scientifiques*, 13 *Mars*, 1869; *page* 232).

‡ Read "flame-temperatures."

‖ *Lecons sur la Dissociation*, p. 231.

§ *Pogg. Ann.*, vol. cxxxi, p. 161.

As to the comments made on our conclusion regarding carbonic oxide, that "of all known gases" it gives the highest calorific effects; I am quite ready to confess that Mr. WATTS has convicted us of a lack of precision of language which we ought to have avoided. We may, however, plead in mitigation, that our paper was more especially intended to introduce the subject to *practical men*, in available forms; and that we therefore, with an inadvertence not wholly excusable, held in mind only such gases as are met with appreciably in practice. Mr. WATTS therefore puts us again under obligation here.

Some readers will doubtless conclude, from Mr. WATTS's last paragraph, that he suspects Professor SILLIMAN and myself of ignorance regarding the experiments of BUNSEN and DEVILLE on the actual temperatures of the flames of hydrogen and carbonic oxide. The readers of this Journal will not heed such an insinuation, in view of discussions by the present writer, of the researches of these two chemists, that have appeared in these columns, antedating the presentation of the joint Salem paper. (See particularly *Amer. Gas-Light Journal* of Aug. 2, 1869, p. 84.) One sentence in that paper might, I should think, have preented such an impression on the part of Mr. WATTS. This is where we say that our figure 6851° C. "is the temperature actually possible in the flame of the compound blow-pipe *were the combustion instantaneous and complete*" (the italics being in the original). The subject belonging, however, to that of flame-temperatures, which we had not as yet strictly entered upon, was deferred by us for the time being.

Finally, I cannot but submit that Mr. WATTS, in presenting his concluding table, has in several ways, inadvertently, laid himself open to criticism of a class similar to most of that applied to us; including the accusation of confusion of ideas and terms. I shall be satisfied with respectfully presenting two questions. If the second column comprises the actual flame-temperatures, as determined by experiment, why does he designate the first column also "flame-temperatures"? Are not these latter figures precisely what we have designated as total *calorific powers* or *effects*, instead of temperatures?

HENRY WURTZ.

American Chemical News.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

NINETEENTH MEETING, AT TROY, AUGUST 17TH, 1870.

The circular of the Local Committee has just come to hand, and we find that the time for holding the nineteenth meeting of the Association has been changed, by consent of the Standing Committee, to Wednesday, August 17th, 1870, at 10 o'clock, A. M. We extract:

"It will be the aim of the Local Committee to make the sojourn of the members of the Association in Troy pleasant, as well as profitable in a scientific point of view. The usual local courtesies will be extended.

"The committee is giving attention to the facilities for coming to and returning from the city over all routes of travel, and it is hoped that arrangements will be made with the railroad companies, by which half fare will be secured for those attending the meeting.

"Members, and those who wish to become members, are requested, immediately on their arrival, to register their names at the office of the Local Committee, where they will be furnished with a member's ticket, and such information as may be desired, in regard to accommodations, etc.

"Members of the Local Committee will be in waiting at the depot, on the arrival of each train.

"Special arrangements will be made with the proprietors of several hotels and boarding houses, for the accommodation of members, and many citizens have signified their desire to extend hospitality to members of the Association; but in order that all may be provided for, without confusion or delay, it is requested that persons intending to be present at the meeting, will notify the fact to either of the secretaries, at as early a day as practicable, and when possible, state the day they will arrive. The committee will engage rooms at the hotels or boarding houses, for those who request such an arrangement to be made, on receiving early notice.

"Copies of this circular will be supplied to those who wish them for distribution among their scientific friends.

"A second circular, giving further information, especially as to the routes of travel, and directions for members on their arrival in Troy, will be prepared before August 1st, 1870, but will be sent *only to those signifying their intention to be present.*

"☞ Communications should be addressed to B. H. HALL, General Secretary, or H. B. NASON, Corresponding Secretary, Troy, N. Y.

"By order of the committee,

"J. A. GRISWOLD, Chairman.
"B. H. HALL, Gen'l Sec'y.
"H. B. NASON, Cor. Sec'y.

"TROY, June 27th, 1870."

The Chemical History of a Candle.

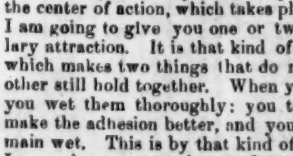
BY PROFESSOR FARADAY.

[A course of Six Lectures delivered before the ROYAL INSTITUTION of Great Britain.]

A CANDLE—THE FLAME—ITS SOURCES—STRUCTURE—MOBILITY—BRIGHTNESS.

[Conclusion of First Lecture.]

Now, how does it get hold of it? There is a beautiful point about that—*capillary attraction*. "Capillary attraction!" you say, "the attraction of hairs." Well, never mind the name; it was given in olden times, before we had a good understanding of what the real power was. It is by what is called capillary attraction that the fuel is conveyed to the part where combustion goes on, and is deposited there, not in a careless way, but very beautifully in the very midst of the center of action, which takes place around it. Now I am going to give you one or two instances of capillary attraction. It is that kind of action or attraction which makes two things that do not dissolve in each other still hold together. When you wash your hands you wet them thoroughly: you take a little soap to make the adhesion better, and you find your hands remain wet. This is by that kind of attraction of which I am about to speak. And what is more; if your hands are not soiled (as they always are by the usages of life) if you put your finger into a little warm water, the water will creep a little way up your finger, though you may not stop to examine it. I have here a substance which is rather porous—a column of salt—and I will pour into the plate at the bottom, not water as it appears, but a saturated solution of salt which cannot absorb more; so that the action which you see, will not be due to its dissolving anything. We may consider the plate to be the candle and the salt the wick, and this solution the melted tallow. I have colored the fluid that you may see the action better. You observe that now I pour in the fluid, it rises and gradually creeps up the salt higher and higher; and provided the column does not tumble over, it will go to the top. If this blue solution were combustible, and we were to place a wick at the top of the salt, it would burn as it entered into the wick. It is a most curious thing to see this kind of action taking place, and to observe how singular some of the circumstances are about it. When you wash your hands you take a towel to wipe off the water, and it is by that kind of wetting, or that kind of attraction, which makes the towel wet with water, that the wick is made wet with tallow. I have known some careless boys and girls (indeed, I have known it to happen to careful people as well) who, having washed their hands and wiped them with a towel, have thrown the towel over the side of the basin, and before long it has drawn all the water out of the basin and conveyed it to the floor, because it happened to be thrown over the side in such a way as to serve the purpose of a siphon. That you may better see the way in which the substances act one upon another, I have here

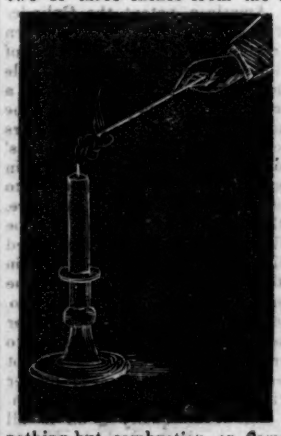


a vessel made of wire gauze filled with water, and you may compare its action to the cotton, in one respect, or to a piece of calico in the other. In fact, wicks are sometimes made of a kind of wire gauze. You will observe this vessel is a porous thing, for if I pour a little water on to the top, it will run out at the bottom. You would be puzzled for a good while, if I asked you what the state of this vessel is, what is inside of it, and why it is there? The vessel is full of water, and yet you see the water goes in and runs out as if it were empty. In order to prove this to you I have only to empty it. The reason is this—the wire being once wetted, remains wet: the meshes are so small that the fluid is attracted so strongly from the one side to the other, as to remain in the vessel although it is porous. In like manner, the particles of melted tallow ascend the cotton, and get to the top: other particles then follow by their mutual attraction for each other, and as they reach the flame, they are gradually burned.

Here is another application of the same principle. You see this bit of cane. I have seen boys about the streets, who were very anxious to appear like men, take a piece of cane and light it and smoke it, as an imitation of a cigar. They are enabled to do so by the permeability of the cane in one direction, and by its capillarity. If I place this piece of cane on a plate containing some camphene (which is very much like paraffine in its general character), exactly in the same manner as the blue fluid rose through the salt will this fluid rise through the piece of cane. There being no pores at the side, the fluid cannot go in that direction, but must pass through its length. Already the fluid is at the top of the cane, and now I can light it and form it into a candle. The fluid has risen by the capillary attraction of the piece of cane, just as it does through the cotton in the candle.

Now the only reason why the candle does not burn all down the side of the wick is that the melted tallow extinguishes the flame. You know that a candle if turned upside down, so as to allow the fuel to run upon the wick, will be put out. The reason is that the flame has not had time to make the fuel hot enough to burn, as it does above, where it is carried in small quantities into the wick, and has all the effect of the heat exercised upon it.

There is another condition which you must learn as regards the candle, without which you would not be able fully to understand the philosophy of it, and that is the vaporous condition of the fuel. In order that you may understand that, let me show you a very pretty but very common-place experiment. If you blow a candle out cleverly, you will see the vapor rise from it. You have, I know, often smelt the vapor of a blown-out candle, and a very bad smell it is; but if you blow it out cleverly, you will be able to see pretty well the vapor into which this solid matter is transformed. I will blow out one of these candles in such a way as not to disturb the air round about, by the continuous action of my breath; and now if I hold a lighted taper two or three inches from the wick, you will observe



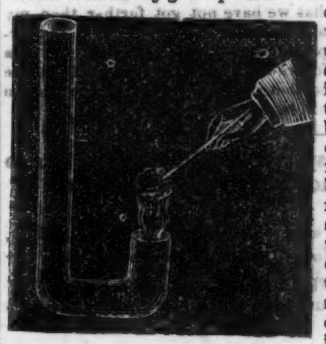
a train of fire going through the air till it reaches the candle. I am obliged to be quick and ready, because if I allow the vapor time to cool, it becomes condensed into a liquid or solid, or the stream of combustible matter gets disturbed.

Now, as to the shape or form of the flame. It concerns us much to know about the condition which the matter of the candle finally assumes at the top of the wick, where you have such beauty and brightness as nothing but combustion or flame can produce. You have the glittering beauty of gold and silver; and the still higher lustre of jewels like the diamond and ruby; but nothing of these comes by comparison near to the brilliancy and beauty of flame. What diamond can shine like flame? It owes its lustre at night time to the very flame shining upon it. The flame shines in darkness, but the light which the diamond has is as nothing, until the flame shines upon it, when it is brilliant again. The candle alone shines by itself and for itself, or for those who have arranged the materials. Now, let us look a little at the form of the flame as you see it under the glass shade. It is steady and equal, and its general form is that which is represented in the diagram, varying with atmospheric disturbances, and also varying with the size of the candle. It

is a bright oblong, brighter at the top than toward the bottom, with the wick in the middle, and beside the wick in the middle certain darker parts toward the bottom where the ignition is not so good as in the part above. I have a drawing here, made many years ago by Hooker, when he made his investigations. It is the drawing of the flame of a lamp, but it will apply to the flame of a candle. The cup of the candle is the vessel or lamp; the melted spermaceti is the oil; and the wick is common to both. Upon that he sits this little flame, and then he represents what is true, a certain quantity of matter rising about it which you do not see, and which, if you have not been here before, or are not familiar with the subject, you will not know of. He has here represented the parts of the surrounding atmosphere that are very essential to the flame and that are always present with it. There is a current formed, which draws the flame out, for the flame which you see is really drawn out by the current, and drawn upward to a great height, just as Hooker has here shown you, by that prolongation of the currrent in the diagram. You may see this by taking a lighted candle and putting it in the sun so as to get its shadow thrown on a piece of paper. How remarkable it is that that thing which is light enough to produce shadows on other objects, can be made to throw its own shadow on a piece of white paper or card, so that you can actually see streaming round the flame something which is not part of the flame, but is ascending and drawing the flame upwards. Now I am going to imitate the sunlight, by applying the voltaic battery to the electric lamp. You now see our sun and its great luminosity; and by placing a candle between it and the screen, we get the shadow of the

flame. You observe the shadow of the candle and of the wick; then there is a darkish part, as represented in the diagram, and then a part which is more distinct. Curiously enough, however, what we see in the shadow as the darkest part of the flame is, in reality, the brightest part, and here you see streaming upward the ascending current of hot air, as shown by Hooker, which draws out the flame, supplies it with air, and cools the sides of the cup of melted fluid.

I can give you a little further illustration for the purpose of showing you how flame goes up or down according to the current. I have here a flame—it is not a candle flame—but you can, no doubt, by this time generalize enough to be able to compare one thing with another—what I am about to do is to change the ascending current that takes the flame upward into a descending current. This I can easily do by the little apparatus you see before me. The flame, as I have said, is not a candle flame, but it is produced by alcohol so that it shall not smoke too much. I will also color the flame with another substance, so that you may trace its course, for with spirit alone you could hardly see enough to have the opportunity of tracing its course of action. By lighting this spirit-of-wine, we have then a flame produced, and you observe that then held in the air it naturally goes upward. You understand now



easily enough why flames go up under ordinary circumstances—it is because of the draft of air by which the combustion is formed. But now by blowing the flame down you see I am enabled to make it go downward into this little chimney, the direction of the current being changed. Before we have concluded this course of lectures, we shall show you a lamp in which the flame goes up, and the smoke goes down, or the flame goes down and the smoke goes up. You see, then, we have the power in this way of varying the flame in different directions.

There are now some other points which I must bring before you. Many of the flames you see here vary much in their shape by the currents of air blowing around them in different directions; but we can, if we like, make flames so that they look like fixtures, and we can photograph them—indeed, we have to photograph them—so that they become fixed to us, if we wish to find out everything concerning them. That, however, is not the only thing I wish to mention. If I take a flame sufficiently large, it does not keep that homogeneous, that uniform condition of shape, but it breaks out with a power of life which is quite wonderful. I am about to use another kind of fuel, but it is truly and fairly representative of the wax or tallow of a candle. I have here a large ball of cotton, which will serve as a wick. And, now that I have immersed it in spirit and lit it, in what way does it differ from an ordinary candle? Why, it differs very much in one respect, that we have a vivacity and power about it, a beauty and life utterly unlike the light presented by a candle. You see those fine tongues of flame rising up. You have the same general disposition of the mass of the flame from below upward, but, in addition to that, you have this remarkable breaking out into tongues which you do not perceive in the case of a candle. Now, why is this? I must explain it to you, because when you understand that perfectly, you will be able to follow me better in what I have to say hereafter. I suppose some here will have made for themselves the experiment I am going to show you. Am I right in supposing that anybody here has played at snapdragon? I do not know a more beautiful illustration of the philosophy of flame, as to a certain part of its history, than the game of snapdragon. First, here is my dish; and let me say, that when you play snapdragon well you ought to have the dish well warmed; you ought also to have warm plums and warm brandy, which, however, I have not got. When you have put the spirit into your dish, you have the cup and the fuel; and are not the raisins acting like wicks? I now throw the plums into the dish, and light the spirits, and you see those beautiful tongues of flame that I have referred to. You have the air creeping in over the edge of the dish forming these tongues. Why? Because through the force of the current and the irregularity of the action of the flame, it cannot flow in one uniform stream. The air flows in so irregularly that you have, what would otherwise be a single image, broken up into a variety of forms, and each of

these little tongues has an independent existence of its own. Indeed, I might say, you have here a multitude of independent candles. You must not imagine that because you see these tongues all at once, that the flame is of this particular shape. A flame of that shape is never so at any one time. Never is a body of flame like that which you just saw rising from the ball, of the shape it appears to you. It consists of a multitude of different shapes, succeeding each other so fast that the eye is only able to take cognizance of them

all at once. In former times, I purposly analyzed a flame of that general character, and this diagram shows you the different parts of which it is composed. They do not occur all at once; it is only because we see these shapes in such rapid succession that they seem to us to exist at one time.

It is too bad that we have not got further than my game of snapdragon, but we must not, under any circumstances, keep you beyond your time. It will be a lesson to me in future to hold you more strictly to the philosophy of the thing than to take up your time so much with these illustrations.

Report of Inspector of Illuminating Gas to First Branch City Council, Baltimore.

We are under obligation to Prof. Wm C. A. Aiken, of Baltimore, Inspector of Illuminating Gas, for the following report, which has been unavoidably crowded out of our columns the past two issues of the Journal:

To the Honorable President and Members of the First Branch of the City Council:

Gentlemen: Early in March the undersigned was requested by a resolution of your honorable body to "furnish all information in regard to the burners used for street lamps and other purposes by the city authorities, and also his opinion as to the merits of the several burners used and which is the most economical."

The reply to this inquiry I beg leave now to present, premising that its long delay has been unavoidable, as the time required for a careful comparison of the large number of sample burners presented could only be found during the brief intervals of professional engagements. Understanding the inquiry as referring to the existing state of things, all my experiments have been conducted simply to determine what are the best burners to use with the gas of the Baltimore Gas Company, when burned under the average maximum pressure, existing over a very large part of our city With gas of uniform quality, the supply of air, the size and form of the orifice of the burner, and the velocity of the issuing jet, will all influence the light-giving power, and thus the same bulk of any gas may yield very different quantities of light, according to the burner used. The orifice may be too large or too small; the velocity of the stream, or in other words, the pressure on the gas, may be too great or too little, and the combustion may be too rapid or too slow.

It is a mistaken idea to think to economize gas by using a burner with too small an orifice; with such we will always find a flame showing a large amount of nonluminous blue base. If, on the other hand, the orifice is too large, the escape of gas will be too abundant, the combustion will be imperfect and the flame will be smoky.

The greatest obstacle to the economical consumption of gas is undoubtedly the great pressure in the street mains. This pressure can be diminished in any building by partially closing the stop-cock behind the meter, between that and the main. But the objection made to this is that it has to be done every month where a wet meter is used, and is therefore troublesome The same object can be accomplished in another manner—that is, we can retard the flow of the gas and consequently diminish its velocity as it escapes from the burner by other means. All burners that profess to economize gas have some contrivance for this purpose. Sometimes a diaphragm of wire gauze and sometimes some fibrous material, as wool or cotton, is placed in the body of the burner; but in time these are liable to become obstructed, and so impervious as to require to be removed and renewed.

Of the various methods employed for checking the flow of gas from the burner, which have come under my notice, the plan adopted in the double burner arrangement appears to be the most economical. The Cylinder burner, the American patent, the Young America, and the Imperial gas economizers, are constructed on this principle. In other forms of burners examined, there are elaborate and ingenious devices intended to accomplish the same thing—to control the flow of gas. Among these I may name the "Index burner," a double burner with an index regulator inside; the "Mill burner," with a screw regulator on the outside, and the "Avery burner," which claims to have a self-acting valve, all apparently not so well fitted for general and common use. The same may be said of some special contrivances for increasing the light of a given flame. Such as "Croll's Platina Perfector," adapted to the Union jet and the cap of the "More Light" burner used on a batwing. The last by interfering with the direct contact between the air and the base of the flame on one side, appears to increase the light by restricting the extent of this non luminous blue base. The action of these will be found noted in the table of results appended. So far as any conclusions can be drawn from my experiments, a brief glance at the table will show that the burners that interpose a check to the flow of gas when used under high pressure, are much better than those that have no such check. Those known as the American patent, the Cylinder burner, and the Imperial gas economizers, have given the most satisfactory record. By substituting one of these for the old fashioned open iron or brass single burners, which offer no obstacle to the flow of gas, a much less quantity can be made to yield the same amount of light. And in that proportion the burners reccomended will prove most economical. "Tufts' street burner," said to be in use on the street lamps in Boston, has connnected with it a regulator intended to equalize the flow of gas under varying pressure. Whether better than those named above could not be determined from my limited examination. It is stated that the double or cylinder burners are largely used in New York city on the public street lamps, and the Young America burners in Cincinnati and in Buffalo In my trials the "American patent" has done better than either of the others. It is hardly necessary to add that all the burners in a gross of any kind are not likely to be equally perfect. The best form of burner ascertained, the material of which it is made, is an important consideration. Of two equally good in all other respects that one will be the best which will last longest unchanged. A metal tipped burner will corrode and become unfit for use by the action of heat much sooner than a lava or porcelain tip, and therefore the latter are to be preferred, Where a very bright light is required, the Argand burner, as a general rule, is the best. But their greater cost and greater trouble in using, with the breakage of chimneys, interpose to prevent their common use. They are not the most economical where a lesser amount of light will suffice; in such case the Batwing, or Union jet is better fitted. Among the Arganda tried, "Sugg's New London Standard," with six-inch chimney, is the most remarkable, supplying the light of eighteen candles by the consumption of four cubic feet of gas per hour. Having but a single sample of the kind I cannot say whether fairly represents the average power.

In conclusion it only remains to return my thanks to those who have kindly supplied burners for examination. To Messrs Rodgers & Son I am indebted for the loan of a very large assortment, including some forty different kinds; to Messrs. Ault & McEvoy for samples of Croll's, Sugg's, and Letheby's English and an assortment of American burners; to Messrs. Davidson & Co., for the "More Light," the Avery, and various others; and to Messrs. Brooks, Grimes, Pope & Cole, Saunders (of the Gas Company's Office,) and McLaughlin, of our own city; and to Messrs. Tufts, of Boston, E. P. Gleason, and Archer, and Pancoast, of New York, and C. Gefrorer, of Philadelphia, for numerous samples of the most reliable burners in use.

Respectfully,
WILLIAM E. A. AIKEN,
Inspector of Illuminating Gas.

The first column of figures in the table gives the pressure on the gas in the street main, represented by the height of a column of water in inches and tenths. The second column gives the estimated consuming power of the burner, in cubic feet per hour; the fourth gives the actual consumption in cubic feet per hour, and the fifth column gives the illuminating power of the burner used. The temperature of the photometer room ranged from 60 deg. to 65 deg. Fah. The candle power of the gas by the standard Argand was 18 candles. No attempt was made to determine which burner would give the most favorable conditions. The only inquiry was which burner would give the most light under the existing conditions. The governor was therefore thrown aside and a connection was made with the street main, and the gas was burned, as when in ordinary use by the public.

Table of Light-giving Power of different Burners.

Union Jet Burners.	Pressure in Street Main.	Pressure at Burner.	Burner rated at cub. feet per hour.	Gas consumed, cub. ft. per per hour.	Illuminating power in Candles.
American patent	3.5	2.1	3	4.75	18
Young America	3.5	2.7	3	3	11
Mill burner, maximum	3.3	1.6	4	6	18
" minimum	3.3	2.1	4	5	15
American patent	3.3	2.1	4	5	17
Iron double burner	3.3	2.3	4	4	9
Cylinder burner	3.3	1.4	4	4.5	16
"	3.3	1.2	4	4	16
"	3.3	1.9	4	5.5	18
Young America	3.3	2.3	4	4.5	18
Imperial burner	3.3	1.6	4	6	17
"	3.3	1.1	4	4	14
Iron single burner, no check	3.3	1.8	4	5.5	15
Mill burner	3.5	1.9	5	5.5	11
Cylinder burner	3.5	1.4	5	4	17
American patent	3.5	2.3	5	3.5	14
Avery valve burner	4.5	1.6	5	5	16
American patent	3.5	1.8	5	4.75	18
Young America	3.5	2	5	5.5	20
Imperial burner	3.5	.9	5	4	11
Iron single burner, no check	3.5	1.8	5	6	16
Mill burner	3.5	1.5	6	5.5	17
Cylinder burner	3.5	1.9	6	5	18
American patent	3.5	1.8	6	5	17
Imperial burner	3.5	1.5	6	5.5	14
Imperial gas economizers	3.5	2.7	3	3	8
" "	3.5	2.2	4	4.5	14
" "	3.5	1.8	5	5.5	17
Glass burner, Myers' patent	4.5	1.6	6	6	19
Burner Croll's plat'a perfector	3.5	2.1	0	4.5	14
" without "	3.5	1.8	5	5.5	17
Index burner	3.5	1.7	5	5.5	10
"	3.5	2.8	1	2.5	7
"	3.5	2.3	2	4	18
"	3.5	2.1	3	4.5	15
Batwing Burners.					
Cylinder burner	3.3	2.6	3	3.75	14
Young America	3.5	2.6	3	3.5	18
American patent	3.5	2.2	3	4.5	19
"	3.5	2.1	4	4.75	19
Cylinder burner	3.5	1.7	4	4.5	20
Young America	3.5	2.2	4	3.5	15
Iron double burner	3.5	2.4	4	4	14
Imperial burner	3.5	1.7	4	6	20
Cylinder burner	3.5	2.	4	5	18
Mill burner, maximum	3.3	1.8	5	6	18
" minimum	3.3	2.1	5	5	16
Cylinder burner	3.3	1.3	5	5	18
Iron double burner	3.3	1.8	5	4.25	16
Cylinder burner	3.3	2.1	5	4.25	16
American patent	3.3	1.7	5	5.25	18
Young America	3.3	1.7	5	5.25	18
Imperial burner	3.5	1.4	5	6	16
Mill Burner	3.5	1.5	6	5.5	17
Cylinder burner	3.5	1.2	6	6	20
Iron double burner	3.5	1.6	6	5	18
American patent	3.5	1.9	6	5	17
Young America	3.5	1.2	6	4.5	17
Imperial burner	3.5	1.	6	6	20
Glass burner, Myers' patent	3.5	1.5		6	19
Tuft's patent street burner	3.5	2.2		3	14
More light patent, with cap	3.5	1.9	5	5.5	19
" " without cap	3.5	1.9	5	5.5	14
" " with cap fix'd	3.5	1.9	5	5	16
Iron double burner for st. lamp	3.5	1.8	5	5	13
" " " "	3.5	2.2	5	4.5	11
" " " "	3.5	1.5	5	5.5	14
" " " "	3.5	2	5	4.5	12
" " " "	3.5	1.8	5		13
" " " "	3.5	2.2	5	4 25	13
" " " "	3.5	2.4	5	5 55	18
" " " "	3.5	2.5	5	5.5	14
" " " "	3.5	2.1	5	6.25	16

Argand Burners.	Pressure in Street Main.	Diameter of Ring.	Number of Holes.	Height of Chimney, inch.	Pressure at Burner.	Consumption per hour per cub. ft.	Illuminating power in Candles.
Noiseless Argand	3.5	1	40	7	.6	6.	19
"	3.5	1	40	7	.6	5.5	18
"	3.5	¾	36	7	.6	4.5	15
Rhode Island Argand	3.5	1	40	7	1.1	4.5	14
" "	3.5	1	40	7	.6	6.	18
" "	3.5	1	40	7	.5	5.	16
Sugg's, Letheby's stand'd,	3.5	¾	15	7	.8	4.5	16
Sugg's New London "	3.5	¾	24	6	.3	4.	18
Standard Argand	3.5	1	15	7	.4	5.	18

British Association of Gas Managers.

The seventh annual general meeting of this Association was held Tuesday, June 7, at the rooms of the Society of Arts, John street, Adelphi, London. The Vice-President Magnus Ohren, Esq., A. I. C. E. (in the absence of the President Mr. Esson, in consequence of illness) delivered an extended inaugural address, from which we collate such portions as will be interesting to the gas fraternity in this country.

Gas Purification and Scrubbers.

The next thing of importance, after making the gas in good productive *quantity* is *quality*. Gas can be made practically free from impurities, and it is but right that the consuming public should have pure gas to burn, especially now that chemical science has shown us the way to free our gas from those impurities which thirty years ago we supplied with the gas, because we had not then the knowledge required to grapple with

those difficulties. About that time, with gas at 10s per 1000 cubic feet I remember perfectly well, when testing the gas for sulphuretted hydrogen by means of acetate of lead—the only test for sulphur known to gas engineers of that day—I often found the test of a shade which, if found in the gas of the present day, would make Dr. Letheby's hair stand on end with horror at the amount of impurity. Mind, I am giving you my experience of 30 years ago, when I was a pupil of the engineer of one of the London gas companies. Chemical science has, however, made vast strides since then, and the case is very different in the present day. Gas can now be, and should be, sent out to the public free from visible sulphuretted hydrogen and ammonia: and, further, no well regulated gas establishment should now send out gas of a less illuminating power than 12 standard sperm candles, burning 120 grains, when compared with five feet of gas burnt through the Letheby's London burner, nor less than 13½ candles burnt through the gas referees' or Sugg's new "London" burner, and I believe the consumers have no cause to complain that this is not done. Gas managers are constantly trying new inventions to improve the purity and illuminating power of gas, and when thoroughly proved the members are always willing to impart the knowledge so gleaned, and there is scarcely a meeting of this Association but we have a paper on purification in some of its branches, showing the proper importance that members attach to this subject. On the present occasion we have two such papers, one by Mr. Upward of the Chartered Gas Company, on purification; and one by Mr. George Livesey, of the South Metropolitan Gas Company, on scrubbers. I must, however, particularly draw your attention to scrubbers. Of all apparatus in general use upon a gas factory, probably no portion is so uncertain and unsatisfactory in its operation as the ordinary coke scrubber. Care is taken, in designing this purifier, to provide scrubbing surface of proper proportion to the gas made, but the maintenance of this proportion is a question of time, and often of very little time. Under very favorable conditions, as regards the kind of coal used and the condensing apparatus through which the gas has previously passed, the scrubber may perform the duty for which it was intended; but almost always when a scrubber is opened it is found that there is just sufficient room in the center to pass the volume of gas for the time being, all other openings being filled with deposit. Some admirable arrangements for distributing liquor are in use, but no mode of distribution of water or liquor that I know of can prevent or dislodge this deposit. Steam has been successfully used to prolong the life of the material, and save the cost of changing it; but any force the water may possess is exhausted by the upper strata of scrubbing material, and it simply finds its way to the central apertures through which the gas ascends. My brother, Mr. John Ohren, the engineer-in-chief of the Rio de Janeiro Gas Company, substituted plates of iron for trays of coke, and with good effect; and Mr. George Livesey will explain in his paper an admirable arrangement by means of thin boards placed edgeways tier above tier, which he has used at his works, and which, he says, is very effective, never gets out of order, and never wants changing. Well, so far, we seem to be arriving at a point of perfection in scrubbers; but then we find we have arrived at the same time at a knowledge that the scrubber is, after all, not the friend to gas managers it was supposed to be. We know that scrubbing is very effective in taking out the ammonia from the gas, and it having been found necessary to reduce the amount of sulphur compounds contained in the gas, to comply with the conditions required by the Metropolis Gas Act of 1860, that gas should not contain more than 20 grains of sulphur in every 100 cubic feet, the ingenuity of gas managers and gas chemists became taxed to devise means to this end. Among other experiments, the washing of the gas in the scrubbers, more particularly with ammoniacal liquor, was found to be beneficial in removing sulphur, and it was supposed that the greater the scrubbing surface the greater the amount of sulphur removed; but to the present time we have no reliable data to go upon. From careful testings of the gas for sulphur compounds, before and after entering the scrubber, to ascertain the full effect of the working of that part of the purifying apparatus, we find that the amount of sulphur in the gas varies from day to day in a remarkable manner, and from causes not yet ascertained.

EXPERIMENTS OF THE GAS REFEREES.

The board of gas referees have to determine a maximum for the sulphur compounds, and therefore their proceedings are of extreme importance to the London gas companies. Averages are of little use here, for the London Gas Acts of 1868-9 require that the maximum shall, under heavy penalties, be observed for each single day. The referees have not yet issued any public report on the subject, but I learn that experiments on a manufacturing scale—the only ones reliable—have been made, and are still in progress, under the instructions of the referees, which unquestionably will throw much light on this difficult point. Among others, a systematic series of experiments is being made to ascertain the efficiency of each separate part of the various purifying processes employed in gas works. My successor in office will be in a position to comment upon these experiments at the next annual meeting of the society. For myself, judging from the information given to me by the engineers conducting those experiments, I must say that the idea entertained in many quarters of trusting to increased scrubbing power as a means of lessening the amount of sulphur in the gas is wholly contradicted by the result of those experiments, so far as they have gone. I may add, that if the referees properly and wisely discharge the important duties devolving from time to time upon them, the result cannot fail to be of much use to the science of gas manufacture; for they have, what none of us ever had before, the means of instituting careful experiments, upon a uniform plan, in each of the large gas-works under their supervision, and thereby combining and bringing to a focus the knowledge of the able engineers of the several companies, and sifting out the truth in a practical and reliable manner.

TESTING GAS FOR SULPHUR.

I cannot quit this subject without calling your attention to a new apparatus which the gas referees have devised for the testing of gas for sulphur compounds other than sulphuretted hydrogen. I have obtained from Mr. Sugg a specimen of this apparatus. The main differende between it and Letheby's apparatus is twofold—firstly, instead of a large empty cylinder, the referees use a small upright cylinder filled with glass balls, a sort of scrubber, in fact; secondly, a careful adjustment has been made to secure a good draught. The bottom of the Letheby apparatus is left open, and also the area of the lower end of the "trumpet tube" is considerably larger than that of the upper end; accordingly the instrument, besides requiring to be carefully guarded against side draughts, is liable to this drawback, that the external air, although drawn up by the heat to the height of the burner, cannot all pass upwards through the narrow orifice above, and consequently is liable to regurgitate and escape again at the lower end; in the referees instrument this is prevented by covering the lower end of the trumpet-tube, and narrowing the admission of air in such a way as to improve the draught, which at the same time protects the lower end of the instrument from the action of external currents. From experiments made with the two instruments, I find that the amount of sulphur obtained by the referees test is as 30 grains against 24 grains obtained by the Letheby apparatus. I need hardly say that the adoption of this more efficient test for the sulphur compounds must in justice to the gas companies, be properly taken into account by the referees before they fix the maximum of sulphur to be allowed in the gas of the companies placed under their supervision by the recent Acts of Parliament.

AUTOMATIC LAMY-LIGHTERS.

Since our last meeting we have two additional "iron lamplighters"—the hydraulic lamplighter and the pneumatic lamplighter, the first designed by Mr. Hunter, an engineer, but not connected with gas-works. He has produced an apparatus to be worked by hydraulic power. The peculiar feature is that by one operation the tap is opened, a match struck, and the gas lighted. A service-pipe is to be laid throughout the district to be lighted, with branches to each lamp. The pipes are charged with water, and the pressure required is given and maintained from a tank placed at the required elevation. Inside each lamp post is to be placed a small cylinder, to the piston of which is attached a rod. The top of this rod is serrated, and gears into a toothed wheel attached to the plug of the lamp-tap, which is turned round, and opened as the rod rises. A small fusee drops from a reservoir, and is carried by a swivel plate to a piece of roughened spring, on which it is rubbed and ignited. It is then carried round past the burner, the gas lighted, and the fusee drops to the bottom of the lantern. In the morning, when the gas is to be extinguished, the pressure of water is taken off the cylinders and an escape-tap opened, the pistons drop with the weight of the rod, and the taps are turned off. It is proposed that, as the lamps are cleaned weekly, the lamp cleaner shall supply the reservoir with a week's supply of matches.

Now, up to this point all is satisfactory. I have tried the model apparatus repeatedly, and found it to work well, the only exception to the general plan, as worked by the model being the ignition of the matches, as they occasionally fail; but this is a difficulty of little moment, as good matches can easily be procured. My great objection was that in a hilly district the pressure of water could not be taken off the cylinders; therefore the pistons in the lamps on the side of a hill would be kept up by the pressure from the top of the hill, and as it would be out of the question to take the water out of the pipes every morning, and recharge them before night for relighting, the lamps would continue burning. Mr. Hunter, when I discussed the matter with him, thought to get over the difficulty by weighting the rods, and varying the size of the cylinder; but he took my advice not to commence in a hilly district, and he is prosecuting his operations as Southport. Another greater difficulty I foresee it the freezing of the water in the pipes in winter, which, I fear, will curtail his richly deserved reward for his beautiful invention. One hint I may throw out for his consideration—the use of sea water. It is not only at the sea-side that this can be got, but as a company is forming to supply sea water in London at a cheap rate, the London gas companies can be supplied with sea water for their iron lamplighters, unless it be superseded by the pneumatic lamplighter, the second invention mentioned, the patentees of which, Messrs. Stephenson, Bartholomew, and King, have no doubt foreseen the difficulties I have spoken of. Their "iron lamplighter" is worked with air instead of water, and from all I at present see will prove a success. There is a model working apparatus on the table, and members will not only have a chance of seeing the working of it, but have an explanation, if time will permit.

Since writing the foregoing, I have heard from Mr. Hunter. He says: "I am happy to say the apparatus works well. All through the last winter it has been entirely uneffected in its working by frost; the lamps light in rapid succession, so that the cylinders are not all required to be filled at the same moment, consequently a small water pipe will answer the purpose.

GAS FROM COAL TAR.

[Our readers are advised not to accept this *sine grano salis*. We shall throw out some remarks thereanent at an early day.—H. W.]

While on the subject of tar, I may state that another important use tar is likely to put to is the manufacture of gas. As tar contains a large quantity of rich hydrocarbons, it has engaged a large share of the attention of gas managers, who for many years have, by various means, endeavoured to convert the valuable fluids which it contains into permanent gasses. Their attempts, however, have not been attended with anything like success—principally because it was found that solid deposits and naphthaline caused obstructions in the mains and pipes, and carbon on the retorts, without the anticipated increased quantity of gas. Improvement has, however, been introduced at Cork, by Messrs. Still and Lane, and although the new process has been in operation there over a year, no deposits have been observed in either the manufacturing or distributing apparatus.

The essential difference in their process, which by-the-by, they have patented, consists in the thorough amalgamation, by suitable machinery, of the tar with a portion of the coal which is to be carbonized. From 30 to 40 gallons of tar are mixed and ground up with with three-quarters of a ton of coal and a quarter of a ton of breeze; the proportion to be used is 25 per cent. of the total quantity of coal to be carbonized.

The advantages claimed for the process are a large yield of gas, increased illuminating power and a reconversion of breeze into coke, its particles being cemented together by the pitch of the tar. It is said that inferior Welsh coal treated under this patent can be made to yield 15 candle gas, tested by the old London burner. The theory of the process appears to be this—that while in former experiments the tar was merely distilled, in this process it is in a great measure decomposed and the poorer gases coming from the coal while in their nascent state combine with the rich hydrocarbons of the tar, which are thus converted into permanent gases, instead of condensing and forming obstructions in the apparatus. The patentees have given a long trial to the process before endeavoring to get it adopted by other companies. Some trials have been made in Dublin, extending over several weeks, which have resulted, it is reported, in considerable economy of manufacture. If further experience confirms these results, gas companies—particularly where the iron stoker is in use—will no doubt adopt the process, and as a consequence, tar will rise in price, as a great quantity will be withdrawn from sale. Gas managers will do well to bear this in mind in making their contracts for the sale of tar.

GAS FOR HEATING AND COOKING PURPOSES.

We have a paper by Mr. Goddard, of Ipswich, on the "Application of Gas to the Generation of Steam." Any application of gas to the uses of man must be a benefit to the gas producer as well as to the gas consumer, and therefore the application of gas to the generation of steam, whether for machine power or for cooking, if effective, must cause an increase in the sale of gas. That gas can be used for cooking with advantage is a fact known to many of us. Mr. Somerville, of Dublin, introduced cooking-stoves at Maidstone, and so satisfied were the consumers with the use of his stoves, that they were taken faster than he could make them, and his summer consumption of gas was largely increased thereby. I believe he has also introduced them at Dublin, and I have no doubt with good results. Hitherto the great drawback to cooking stoves has been the smell, but by using stoves made with glazed tiles and atmospheric burners, there is no smell, and they can be fixed in any part of the house, as they re-

quire no chimney. The benefit to be derived from the use of these stoves in small houses during the summer months is self-evident. From experiments made by myself, I have found that the cost of gas for cooking a joint is very much less than coal, if the fire has to be made for that purpose only. These stoves have just been introduced to our consumers; they cost the company £5 5s. each, and we let them out at a rental of 2s. 6d. per quarter. I recommend gas managers to consider this subject, with a view to increase their summer consumption.

[Owing to the crowded state of our columns, we have to omit two interesting tables in connection with this subject.]

PHOTOMETRY.

Among the novelties of photometry is the apparatus designed by Mr. F. W. Hartley, of Westminster. The apparatus consists of three photometers converging to a common center, which is occupied by one candle, so that three operators may determine the illuminating power of any one of three gases compared with one and the same candle. Fortunately the days are passing away when two or more gas companies were allowed to supply gas in the same street, generally resulting in a waste of the shareholders money, and a loss to the consumer, otherwise this photometer would have been useful to try one company's gas against another, but now I do not see the object to be obtained. I can understand three operators testing the gas at one time, and then comparing their results. I believe they would be nearer the truth than three separate testings by a single burner; not that I put much faith in the report of difference in human vision. I believe the difference to be in the candle, not in the vision: and I am led to infer, if this be so, that Mr. Hartley's instrument would be more perfect if his gas were in the centre, and the candles placed at the three points. The difficulty that I have experienced most in photometry is the variation in the amount of light given by different sperm candles, and even different parts of the same candle, and under different temperatures; and I conceive that the more we multiply the candles the nearer we arrive at a correct average. Supposing, then, we have three pairs of candles, two at each point, by this means any variation in one pair of candles will be checked by the other two pairs; for although not impossible, yet I think it hardly likely that all the candles would err exactly in the same way; at any rate a certain number of experiments must necessarily end in a more perfect result than at present obtained with the single apparatus, and this fact I believe was maintained by Mr. Kirkham in a paper read by him at the Institution of Civil Engineers last year.

BURNERS.

I take this opportunity to direct your attention to a report made to the Board of Trade by the referees appointed under the City of London Gas Act, 1868. One of the questions addressed to the referees was to determine the burner to be employed in testing the gas for illuminating power. As appears from the report, the referees carefully examined the various kinds of burners in use, and also some new ones, and the result of their inquiries was the adoption of a burner submitted to them by Mr. William Sugg, now known as "Sugg's New London Burner"—in all respects a beautiful instrument, superior to any hitherto invented.

In the referees report, the burners in use by the consumer are commented upon. How often has this subject been commented upon, and the unfortunate consumer, after trying burner after burner, drags on his life in a state of semi-darkness? He has gone past complaining, and has a belief that the fault is in the *gas*, not the burners, and that he is being victimized by the gas company.

It is therefore a matter of rejoicing to gas managers that the gas referees have probed this sore point—with a desire to heal it. Their inquiries revealed in an extraordinary manner the badness of the burners in common use; their investigations, as detailed in their report, show that some of the burners give barely 20 per cent. of the real illuminating power, and on inspecting various large establishments, the burners in use gave only 55 per cent. of the illuminating power obtainable from the gas. These facts prove in a remarkable manner how groundless has been the bitter outcry on the part of the public against gas companies. They show that the fault has really lain with the consumers themselves, who have been in the habit of wasting the gas supplied to them, and throwing away very large sums annually, by the use of shamefully bad burners. This is a point of great importance to the public, and it is to be hoped that one result of the publicity given to this report by the Board of Trade will be to lead consumers to adopt better burners, a change which will be greatly in their own interest, and which ought certainly to lead to a cessation, or, if that be hopeless, at least to a diminution of the outcry against the gas companies. At the same time let me point out to gas managers that it is their duty to assist consumers to a selection of burners. For years past I have done this, and we recommend Sugg's steatite burner and the slit fishtail as far preferable to the 2-hole fishtail. In a paper read by Mr. Sugg at our last meeting, on burners, the Brönner burner was mentioned as giving an illuminating power of 12 candles, with a consumption of five feet per hour. I have made some experiments with this burner, and am pleased with the results. These burners are all split or bat's-wing burners, and glasses are made to suit that description of burner. They are made of various sizes, from one to eight feet. Mr. Greene, of King William Street, London Bridge, is the London agent for these burners, and they have given great satisfaction in places where they have been fixed. Mr. Sugg has also a new burner which contains in the socket a regulator; by this means you can with four sizes effect the same object as the Brönner burner with eight or nine sizes.

VALVES.

Who is there so fortunate as not to have been troubled with leaky valves, and what mischief have they not caused? I hope next session we shall have a paper on valves, and I would draw attention to Messrs. C. and W. Walker's new patent for improvements in centre-valves, "Cathels and Terrace's" patent four-way disc gas-valves, Mr. George Livesey's water-valve, Thorneloe & Co.'s patent flexible valves, and C. and W. Walker's slide-valves for large sizes. Messrs. Walker are manufacturing the centre-valves for the Beckton works. The centre-valves hitherto made by them were liable to leak from settlements of naphthaline and dirt upon their surface facings. Some of these deposits were of a slippery nature, so that the valves in turning slid over them, instead of throwing them off, and became leaky. Messrs. Walker's improvement overcomes this difficulty by means of casting surfaced bars, or covering facings, in the valve, which do not interfere with the passage of the gas, but always cover the surfaced facings of the partitions of the body, thus protecting that part from injury of every kind, and rendering the valve perfectly tight. A gentleman will be in attendance with a model and drawings for the inspection of members; he will also exhibit a drawing of the new wedge-valve. The valve itself is no longer a disc plate with a spring behind, but a rigid solid wedge of cast iron, having two perfectly surfaced facings fitting the facings inside the body casting: it is worked by a powerful screw, and is said to be perfectly gas tight. Messrs. Cathels and Terrace's are improvements on their well-known four-way gas-valves, and consist of a simplified arrangement of the gas-ways through the valve, reducing it in size and weight, the ports being now all on one level, the disc being actuated by one movement, instead of two, as formerly; and last, though not least, by the impossibility by this arrangement of accidentally shutting back the gas, because the closing of one gas-way simultaneously closes another. The principle will be easily understood by an inspection of a model of the valve on the table. Mr. Livesey's water-valve differs entirely from the old water-valve. It is very simple, but no doubt very effective. It has no facing, springs, or wedges to get out of order, and is easily worked. I look upon it as a valuable invention. Messrs. Thorneloe's valve appears to be an adaptation of the principle of Morton's retort lid, and will, no doubt, do very well for small mains.

[In our next we shall give at length, with the interesting discussion thereon, the first paper read, by Mr. CATHELS, "On Setting and Working Retorts."

Correspondence.

[Correspondents in all cases should sign their communications with their names and address in full, not necessarily for publication, but as a guarantee of good faith.—EDS.]

Forewarned Forearmed! Can Exhausters Draw In Air?

BOSTON, June 28, 1870.

Messrs. Editors: In these days, when the tendency is to draw gas directly from the retort, without the intervention of the hydraulic seal, it will not be amiss to detail a direct experiment, in which it was proved that air could be drawn in by the exhauster, in dangerous quantities. One of the neighboring superintendents, who has adopted one of the various means of doing without the seal on his hydraulic main, while making gas, and who regulates his exhauster so that a pressure gauge direct from that main shows only 1-8 inch pressure, informed me that when he ran the exhauster so as to have a pressure less than 0, that he was able to increase the speed of his meter largely, and he wanted to know to what this increase was due. Being desirous of seeing this for myself, I went to the works with an eudiometer and chemicals, for the purpose of testing the quality of the gas under the two different conditions.

In the first experiment with a pressure of 1-8 inch on the retorts, the quality was determined when the charge was nearly exhausted, and the make from two benches of fives was only ten feet in four minutes. I found—

Sulphuretted Hydrogen	0.5 p. ct.
Carbonic Acid	2.0 "
Oxygen	0.4 "
Carbonic Oxide	4.3 "

Now, upon increasing the action of the exhauster so as to produce the exhaustion of two inches upon the retort, the meter was made to register just ten times as fast, or 100 cubic feet in four minutes, and I found—

Sulphuretted Hydrogen	.4 p. ct.
Carbonic Acid	2.6 "
Oxygen, *at least*	10.0 "
Carbonic Oxide, *about*	8.0 "

Ten per cent of oxygen is equivalent to 50 per cent of atmospheric air. And this quantity *at least* must have been drawn in, or 5-9ths of total increase, as registered by the meter. The presence of an increase of carbonic acid, or carbonic oxide, may have been due to the *combustion* of *air* thus drawn in the retort, or they may have been drawn in directly from the furnace surrounding the retorts.

To my mind one thing is very clear, viz., that it is *very dangerous* to exhaust so that the pressure on the inside of the retort is below 0, because of the difficulty of making or keeping the joints about the mouth-piece tight; and if these do leak there is no ready means of detecting the leak, since nothing can escape outward to show it, and with such leak it is quite possible to form inside the mains and pipes, an explosive mixture ready at the slightest touch of flame to cause destruction and death.

Respectfully yours,

F. E. S.

CONTAMINATION OF GAS BY AIR.

[Our readers will remember the joint paper of Professor SILLIMAN and the Editor, on the important subject of The Effect of Air in reducing the candle power of gas; published in this REPERTORY, No 12, Aug. 16, 1869. The immediate occasion of this investigation was the discovery, *made first by analysis* and unsuspected before, of a large ingress of air, due to defects in the machinery, in the Gas Works at Fair Haven, Conn. This illustrates the importance of frequent chemical analyses of gas, a subject so much neglected hitherto. The detection and accurate determination of air in gas belongs to the most delicate operations of eudiometry. My object here is to say that I have had for some time on hand a special editorial article on this subject of air in gas, which has been crowded out, but for which we shall endeavor to make room in our next, deferring till then our comments on this valuable communication of the able State Gas Inspector of Massachusetts.—H. W.]

Recent American Patents.

Pertaining to the Specialties of this Journal, from the 2d to the 9th of July, 1870.

104,403.—Rotary Pump.—William A. Allyn, Boston, Mass.

104,428.—Water Wheel.—Alpheus C. Corpe, Stafford, Conn.

104,469.—Rotary Pump.—Augnst Leuchtweiss, Cincinnati, Ohio.

104,471.—Artificial Fuel.—E. F. Loiseau and C. F. Requin, Nashville, Tenn.

104,500.—Turbine Water Wheel.—B. F. Samson, West Brookfield, Mass.

104,501.—Steam Radiator.—Sidney Sanders, Springfield, Mass.

104,510 Steam Heater.—Samuel D. Tillman, Jersey City, N. J.

104,511.—Steam Generator.—Samuel D. Tillman, Jersey City, N. J.

104,516.—Shield For Gas Burners.—Hiram J. Wattles, Rockford, Ill.

104,522.—Steam Generator.—S. Lloyd Wiegand, Philadelphia, Pa.

104,531.—Gas Heater.—Amos Adams, Sturgis, Mich.

104,538.—Steam Generator.—Wm. H. Arthur, Newport, Ky.

104,579.—Water Wheel.—Willian Greenwell, Ripley, Ill.

104,600.—Water Wheel.—James C. Kelly, Groveland, N. Y.

104,604.—Pump.—R. M. Lafferty (assignor to himself and E. P. Smith), Three Rivers, Mich.

103,605.—Water Elevator.—James F. Latimer, Detroit, Mich.

104,616.—Steam Pump.—J. R. Maxwell and Ezra Cope, Cincinnati, Ohio.

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Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine.
*** Reference to them is requested. 204-1y

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3rd. When a stoppage of gas in stand pipe occurs, the column can be lifted out, the pipe detached, cleaned, and replaced in fifteen minutes; no digging being required as is now done with the old Post.

4th. A lighter and better casting can be made from this patent, and it can be handled better, owing to its length and lightness.

5th. In case a broken column cannot be repaired, one third of the original cost is saved by the base being secured and perfect.

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Certificate.

ST. LOUIS, September 1, 1869.

I have examined a new Lamp Post, the Branson patent, and unhesitatingly pronounce it to be the best thing of the kind I have ever seen. Posts of this description have been erected in this city, and in my opinion this style of Post should be universally adopted, as I believe it possesses all the advantages claimed for it.

The St. Louis Gas-Light Company have adapted this Post and ordered a large quantity for immediate use.

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Consulting Chemist,
Geologist and General Scientist,
PROFESSOR HENRY WURTZ.

[NOTE BY PROFESSOR WURTZ.—Contributions and items for which I am, as a Scientist, individually responsible, will have attached my full name or initials.—H. W.]

SATURDAY, JULY 16, 1870.

WISHING TO MAKE this Journal an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

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IMPORTANT IMPROVEMENT IN GAS MANUFACTURE.

Every one who is familiar with the history of the discovery of manufacturing gas, and the progress of the art of manufacturing it up to the present time, will have noticed the remarkable fact that little or no improvement has been made in the *process* itself, which is in the same crude state almost, that it was in Dr. Priestley's first experiments, nearly three-fourths of a century ago. The details of the manipulation of the gas, after leaving the retorts, are essentially the same also; but the apparatus for purifying gas, etc., has been improved from time to time, with considerable success. Every one who has studied the chemistry of the process of making gas, cannot have failed to observe its incompleteness as a chemical process; the resulting gaseous products being entirely different from, and inadequate to what would be expected, from a knowledge of the chemical nature and constituents of the article used, whether coal, oil, or other hydro-carbonaceous matter.

Thousands of experiments have been made, and hundreds of thousands of dollars expended, in comparatively futile efforts to make gas upon strictly scientific principles, the experimenters hoping thereby to arrive at a complete economy in the process. Knowing full well, that a saving margin of at least *fifty per cent.* was open for them to work upon.

THE NEW PROCESS.

Being fully impressed with the importance of this subject, we have recently been very much interested in examining a new and patented gas process, now in operation under the auspices of the Citizen's Gas Light Co. of Saratoga, N. Y.

The owners of the patents covering the process, (Messrs. Brown & Co.), entered into a contract with the old Saratoga Gas-Light Co. last year, to supply them with gas at a fixed price for one year. Owing to a misunderstanding, that did not reflect much credit upon the Saratoga Gas-Light Co., the gentlemen who took the contract to supply them with gas, were obliged to start an opposition company, which they successfully did. The old company succumbed, and leased the works to the new company, and they have been successfully running them since that time.

MATERIALS EMPLOYED, PROCESS, COST, ETC.

The gas is made from liquid hydro-carbons, such as naptha, crude petroleum, dead oil and the like, or from solid hydro-carbonaceous materials, such as coal, wood, bitumen, asphalt, etc., or from two or more of these articles in combination.

At present, crude naptha is the article used here Small works will generally prefer to use naptha alone; but large works may find it advantageous to use naptha or the like to a limited extent, say 50 per cent., to enrich the coal gas. In this way, the charges of coal may be run an hour or more longer, to increase the volume to its maximum, while its candle power will be kept up by the rich naptha gas. By this means the coal benches would supply sufficient coke for both, or naptha alone may be employed, and the benches heated with coal—if coke is not accessable.

Briefly, the oil or naptha is put into a still and gradually converted into vapor by a steam coil The vapor is thence conducted into a peculiarly constructed superheater, placed inside a clay or iron retort, set and heated in the usual way. There is in use here one bench of threes, each retort provided with a superheater. The vapor enters the rear of the retorts from the superheater, where it is instantly converted into a fixed gas, and passes into the standpipes and so on, to the gas holder in the usual way, excepting no washing, scrubbing, or purification is necessary. A simple tank and condensing coil being all that is necessary.

One bench of threes will produce 5,000 cubic feet of gas per hour, prepared for distribution, of not less than 20 candle power, equal to 120,000 cubic feet per day of 24 hours. One bench of five will easily produce 200,000 cubic feet per day.

The expense of labor is reduced to a minimum; only an engineer and one fireman being neccessary. The entire process is so nearly automatic, that the manual labor actually required, is a pastime compared to the old process. There is no charging and discharging of retorts, with the hurry and din, and heat and steam, and sulphurous fumes. No troublesome stoppage of stand-pipes, or scaling and decarbonizing of retorts. No laborious and disagreeable purifying process. There are no bad odors, smoke, or soot. Even the retort-house is so tidy, cleanly, and quiet, that one could breakfast in it with a relish.

The first cost of works, it will be readily understood from the foregoing, is much less; scrubbers, washers, and purifiers being dispensed with, and only one-tenth the number of benches being required to produce a given amount of gas, and, owing to the low heats employed, the wear and tear is far less.

We are informed by the President of the gas company, that another remarkable feature of this gas is its non-condensability in the mains—none of the drips having yet required to be pumped. The loss by leakage and condensability is therefore exceedingly small, never having exceeded 3 per cent.

A trifle less than 6 gallons of petroleum naptha, costing net, 7 cents per gallon, produces 1,000 cubic feet of gas, having 21 candle power.

By an experimental test made by us personally, July 9th, 1870, the following results were obtained:

The trial lasted one hour. There was in use one bench of 3 retorts, having been heated up of course, previons to the commencement of the trial.

By means of a gauge, the height of the oil in the still was taken at the beginning and ending of the trial, the vacuum gauge indicating a uniform pressure.

The diminution in one hour was 3½ inches. The diameter of the still being 46 inches, gave by calculation a fraction over 7 gallons to the inch, or 17½ gallons total.

Index of Station meter at starting,	990,601
" " " " ending,	995,406
Number of cubic feet produced,	4,805

Equals 5 1-10 gallons to 1,000 cubic feet of gas. 4,805 cubic feet of gas per hour equals 115 320 cubic feet of gas per 24 hours; estimated amount of cake, 1¼ bushels per hour, equals 30 bushels in 24 hours.

Cost of 1,000 cubic feet of gas made from above data running 24 hours would be

420 gals. naptha at 7cts. per gal. - - -	$29 40
30 bus. coke at 11cts. per bushel - -	3 30
2 men at $2.50 per day, each - - -	5 00
2 engineers at $4 per day, each - - -	8 00
115,320 cubic feeet of gas will cost	$45 70

or 39¼ cents per 1,000 cubic feet

The gas made during this experiment was tested by us, and found to be 21 7-10 candle power.

PERMANENCE AND CHARACTER OF THE GAS, ETC.

The mains in one place particularly, are laid only 16 inches under the surface for a space of one-half mile, owing to the difficulty of excavating a very hard unstratified rock. But during last winter, with the thermometer often at and below zero, no trouble of condensation was experienced.

As the gas is more pure than ordinary coal gas, so is the light more clear and agreeable. Its actinic

properties is better—gay colors of the solar spectrum are more readily distinguished by this light. This is especially noticable in the richly colored and ornamented ceilings, walls, and carpets of the grand halls and parlors of the Union Hotel and Congress Hall, etc. Hence it is, ladies and hotel proprietors, and every one in fact, so much admire this light. The wonderful diffusibility and penetration of this light are additional qualities, that at once distinguish it from common gas, to even the casual observer, and will recommend it to the artist, student, literary author, aged people, and all whose pleasure or employment require to use artifical light, and who desire to preserve the eye sight unimpaired.

These works are not of the nature of a small experiment, as the maximum consumption is 70,000 cubic feet per day, with over 10 miles of main in use.

PRICE AND SUPPLY OF NAPTHA, ETC.

Parties who propose to introduce this process into their works, will naturally enquire as to the price and probable supply of naptha.

Petroleum naptha is the lighter portion of petroleum, distilled over in the process of purifying petroleum, to obtain burning and lubricating oils, etc. Until recently this naptha was a drug in market, and refiners used to let thousands of barrels go to waste. It is estimated that there are 5,000 barrels of naptha produced daily, and the price ranges from 4 to 7 cents per gallon, according to the location of the buyer. Many oil refiners will give it away now to have it taken out of their way.

That petroleum is one of the permanent staple productions of our country, which is constantly increasiug, and likely to increase for all time, no one who has given the subject attention seems to doubt, at the present time. Late statistics show that new wells are constantly being bored, and those that are productive, are constantly increasing in excess over those which have ceased to be productive. Besides, it is found that old, and what was considered exhausted wells have, after a time, in many instances, begun to yield oil anew. Showing conclusively, that a supply is constantly being distilled, or eliminated, in nature's stupendous and mysterious laboratory, in the "deep bowels of the earth."

In conclusion we desire to say, that evidently this process is a great stride in the art of making gas, upon true chemical principles. In the old process the charge of coal is thrown into a hot retort—a portion next the retort is distilled at a proper temperatue to produce a fixed gas—but another portion in the center of the charge is distilled at a low temperature, which will only yield oily and condensable matter, and this goes to form the *tar* in the hydraulic main. This is the very *essence*, so to speak, of gas, and is a dead loss to the process in a chemical sense. Again, another portion of the charge becomes too highly heated, and is destructively decomposed, forming either a hard incrustation on the sides of the retorts called gas carbon, or clogs the mouth-piece and stand and bridge-pipes in the form of a combined gummy and sooty matter. Although the gas may be formed properly in one part of the retort, before it escapes a portion becomes re-decomposed and resolved into new chemical combinations, principally carbonic oxide, carbonic acid gas, and free hydrogen. All this is wrong, and to the analytical mind of the scientist; but more especially to the practical mind that comprehends it fully, the old process of gas making appears not only absurd but even ridiculous, when compared with the new process.

That this new process is destined to go rapidly into use, and become very popular, there is no doubt. Its merits are too apparent, and too important, to escape the attention of the capitalist.

Gas companies, and dolders of gas stocks, who believe in good fat dividends, will study into, and discover the value of this process, and adopt it.

Philanthropists and economists will desire to enjoy, and have the public enjoy and participate in the advantages and profits of a light so superior, and so much cheaper than the ordinary gaslight.

GAS-ENGINEERING.

We are pleased to be authorized to inform the Gas Fraternity and the public generally, that Mr WILLIAM FARMER, who has for the past twelve years been under a professional engagement to the *Manhattan Gas-Light Co.*, intends to open an office about the first of September next, in this city; and will be prepared to superintend, or to furnish plans, specifications and estimates, for the erection, alteration or extension of Gas Works, of any capacity, with all the latest improvements. Little need be said by us of the professional qualifications and capacity of Mr. FARMER, as they are familiar to the profession throughout the country. The general public have vouchers for his knowledge and skill, in his original communications to our columns on gas subjects. FARMER'S THEOREM for illuminating power gas, for example, is sufficient alone to establish both the scientific and practical position of this gentleman.

H. W.

ERRATA.

In the editorial in the last issue, under the head of "*Metropolitan Gas Consumption*," a slip of the types may mislead some. The make of the MANHATTAN COMPANY, instead of being 35 and odd millions, should have been 85 and odd.

Answers to Correspondents.

W. H. K. of Vt.—The visible deterioration of gas during extremely cold weather, is caused by the condensation of the valuable hydrocarbon vapors which form the most luminous parts of gas. In warmer climates this does not occur, but in the latitude of your vicinity you may expect such results frequently.

L. E. of N. Y.—A large number of persons claim to have been the original inventors of the dry meter. We believe that the honor of first contriving this important instrument belongs to Mr. James Bogardus of this city, who is widely known on account of his many useful inventions, and as the pioneer in the use of iron for the erection of buildings.

A. J. S. of Md.—In England two qualities are used having different prices. 12 candles is a fair average for the common gas, and 16 to 18 candles for the best or highest price gas. In this country it is about 14 candles.

B. E. B. of Tenn.—The Worthington pumps are very highly spoken of wherever used. Most of our large city gas companies are supplied with them, and their performance is spoken of in the most favorable terms.

J. R. of Phil.—Bunsen's work on Gasometry is the most complete treatise on the subject and should be owned by all who desire thorough instruction on the science. The English translation is beautifully printed, and illustrated with handsome wood cuts.

L. E. of Conn.—The exhauster may by a too energetic action, draw a portion of atmospheric air into the pipes, which of course dilutes the rich gasses and deteriorates their illuminating power.

NEW PUBLICATIONS.

Steiger's Literarischer Monatsbericht.—This literary monthly periodical is the only one published in the German language in the United States, and now enters upon its second volume. Among its very interesting contents will be found an article on the distinguished historian Frederich Kapp, who has just returned to Europe, after twenty years sojourn in this country, and whose works, some of which has been translated, are widely known. Publication office, 22 and 24 Frankfort street, N. Y.

Good Health.—A monthly vehicle of instruction to the people, giving lessons of correct living, as developed by medical science. It is the only work of its class, and occupies an important field, long vacant, and acknowledged to be modelled on the best plan for conveying its peculiar kind of information. Among its writers are the first medical and scientific men of the day; and its articles are written in a pleasing and interesting style, combining entertainment with instruction. Published by Alexander Moore, 11 Bromfield street, Boston. Subscription price $2 per annum, or 20 cents per month.

Life at Home; OR THE FAMILY AND ITS MEMBERS. By Rev Wm. Aikman, D.D. 1 vol. 12mo; nearly 300 pages. S. R. Wells, publisher, 389 Broadway.

This work ought to be in the hand of every family as its contents are well calculated to make home happy. In it are to be found the beauty and blessedness of a family, the relations of husbands and wives, of parents, of children, of brothers and sisters, employers and employed; subjects that ought to meet with attention from all who desire to make domestic happiness a paradise on earth.

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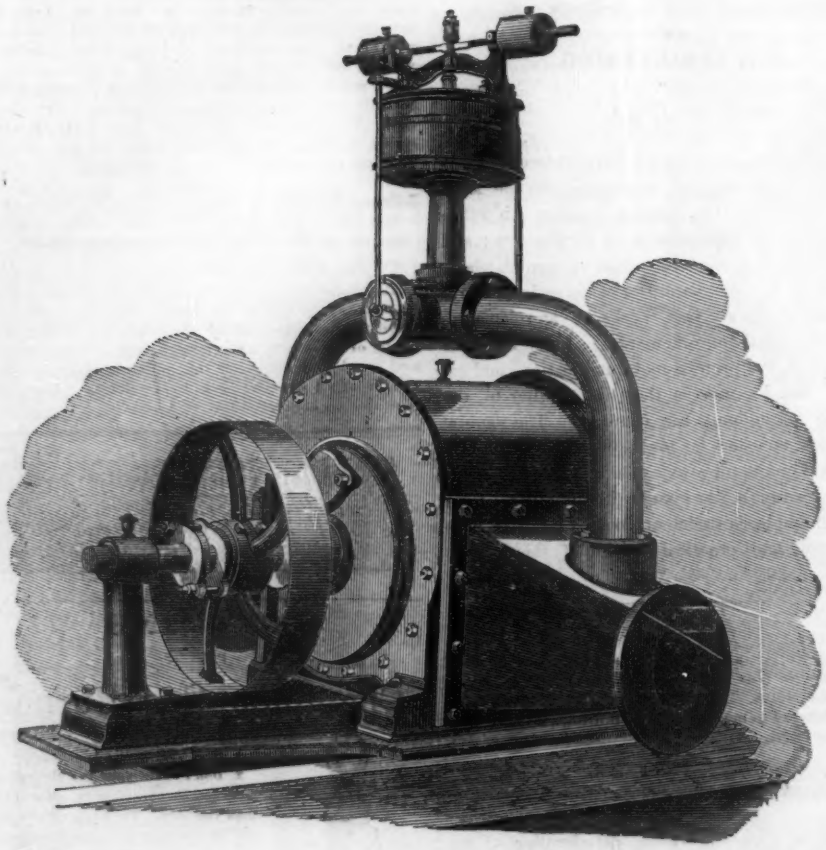

They are made to pass from 4,000 to 150,000 cubic feet of gas per hour; will increase the production and illuminating power of the gas, and add very much to the durability of the retorts, either clay or iron. The Compensator obviates entirely the necessity of water-joints, is compact, durable cleanly, not liable to get out of order, self-acting, quiet, and certain in its operation.

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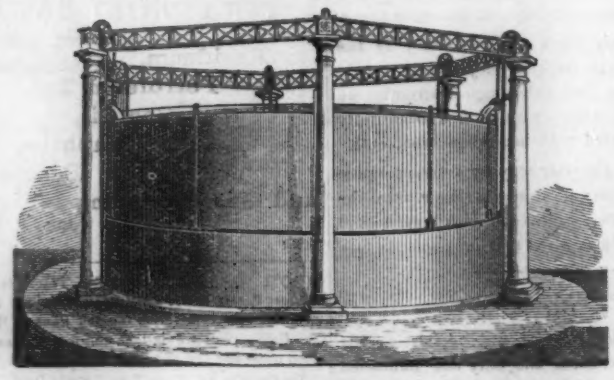

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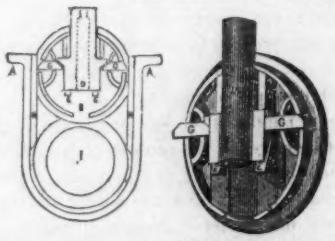
"JOSEPH P. MAYER,
"Superintendent Water Works."

"DAYTON, OHIO, June 27, 1870.

"I have to say that we find them always in order—operating easily under all degrees of pressure. In a word, they have given perfect satisfaction in every particular.

"GEORGE LEHMAN,
"Chairman Water Works Committee."



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"We are now using and have been, since the commencement of our works, your valves, and they are proving entirely satisfactory.

JOHN S. SHORT.
Superintendent Water Works."

"BROOKLYN GAS LIGHT COMPANY.

"I take great pleasure in saying that they give perfect satisfaction—opening easily and quickly, and requiring no effort to start them; even after they have been closed for months.

"A. F. HAVENS, Engineer."

"OFFICE OF PHILADELPHIA GAS WORKS, 14th June, 1870.

"I am pleased to state that the lot of large Gas Valves bought from you (Hart & Birch), as agents of the Ludlow Valve Manufacturing Co, have given me perfect satisfaction. The double gate water valve, bought for a special purpose, also works admirably. We want no better valves. The Indicator on your valves is a great improvement over the old style.

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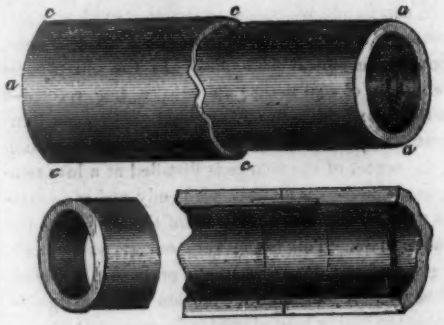

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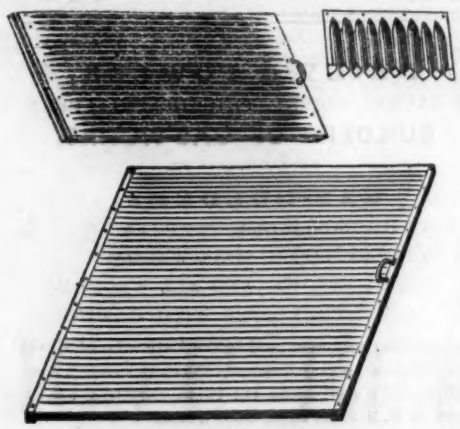

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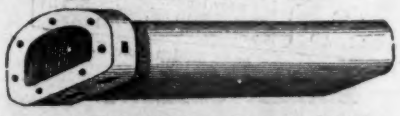

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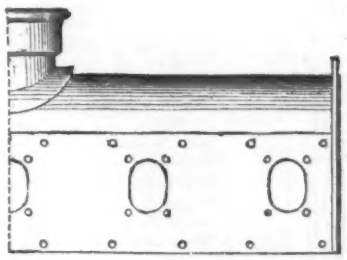

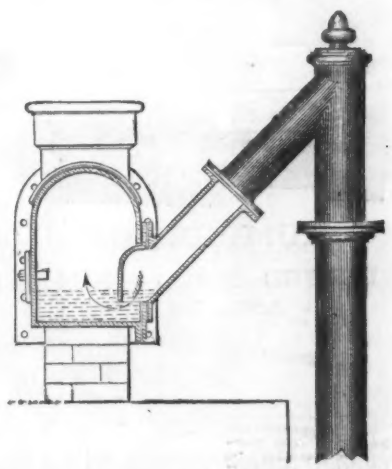

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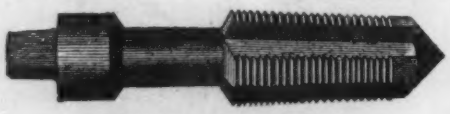

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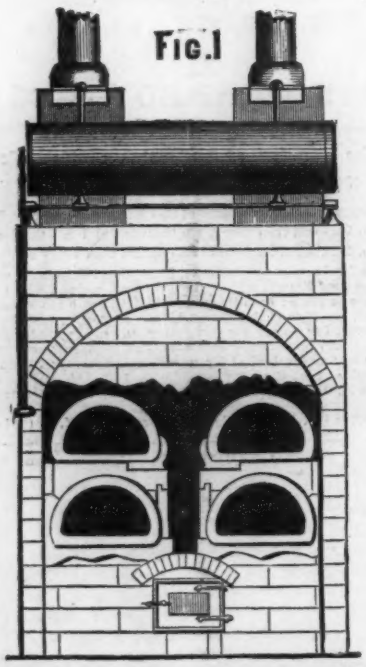

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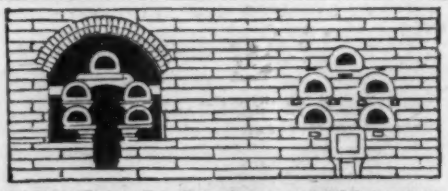

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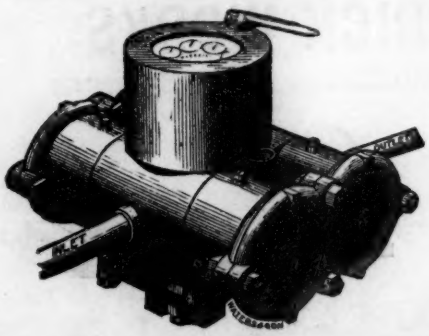

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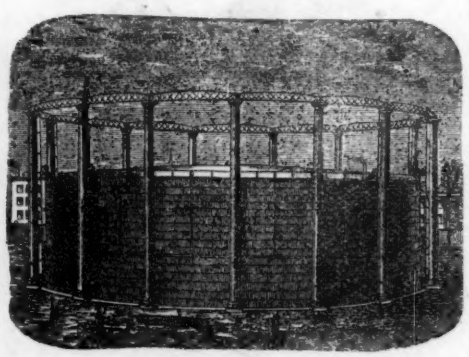

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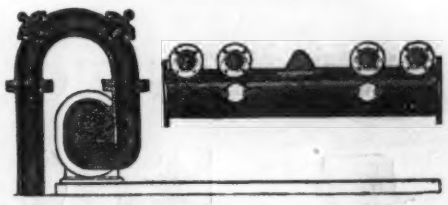

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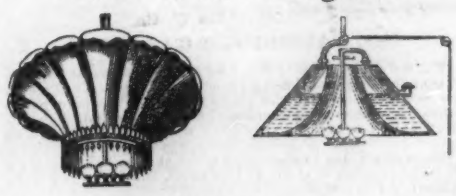

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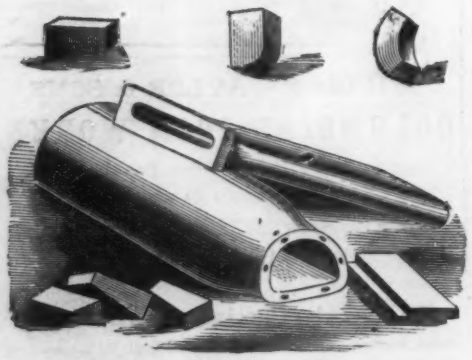

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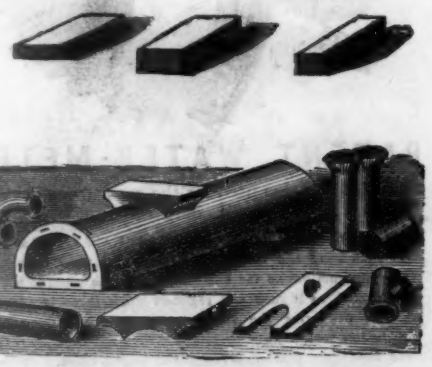

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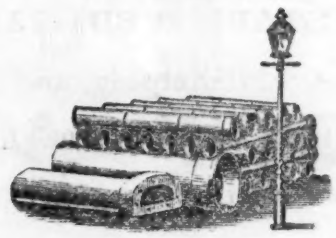

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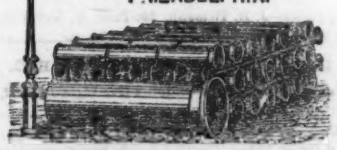

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